Research on Human Capital Mismatching Measurement Based on Foreign Trade Intermediary Effects

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Abstract:

There are little of stocked and increased human capital in border area of Heilongjiang Province, because the development of social economy is unequal which causes attracting and focusing of talents are really weak. However, it leads to a low level about the necessary of human capital due to the poor economic base. As a result, people must consider whether the matching coordination between human capital and physical capital has some impact on human capital. Moreover, used mediating effect model verifies the transmission path. This essay demonstrate three aspects about these problems. Firstly, it measure the coupled coordination of human capital and physical capital in the border areas of Heilongjiang Province from 2006 to 2019. Most of them are judged to be in the range of 0.35 to 0.7, which shows that the coordination of human capital and physical capital matching is low not only in cities but also in counties. In addition, fixed-effects regression analysis is applied to verify that the coordination of human capital and physical capital matching in border areas of Heilongjiang Province has a significant positive effect on economic growth. Finally, a partial mediating effect is verified in a stepwise manner, where the human capital and physical capital match affects the economic growth rate through the mediating variable of foreign trade. Depending on these analyses, this essay mentions strategies which relate to the matching coordination between human capital and physical capital for the development of the population about trade with Russia. The purpose is that rationalizing the flow of talents, optimizing the allocation of human resources, as well as reducing the degree of human capital mismatch.

Keywords: Border areas of Heilongjiang Province, Human capital, Physical capital, Matching and coordination degree, Intermediary effect

I. INTRODUCTION

There is still a large gap between the current level of human capital in China and developed countries. Besides, a serious mismatching issue is still between the limited human capital in China and the regions. This area has the relatively remote geographical location and the harsher natural conditions of the high latitude zone, which leads to imperfect infrastructure and low transportation access. Although there are special ports that make better economic development through trading with Russia, most of the border areas are lagging behind in education and economic development, which results a yearly decrease about the total population, an imbalance in the age structure of the population and a decline in the quality of the labor force. It is estimated to be the stock of human capital is only 52.283 billion yuan in 2019 in Heilongjiang Province,

which returns to restrict the healthy economic and social development of the border areas.

Based on the problem of matching coordination of human capital and physical capital in this area, this essay uses the weight of population share to apportion the stock of human capital in Heilongjiang Province, and analyzes the transmission path of the impact of matching coordination of human capital and physical capital on the economy. According to current problems, the solutions how to increase the stock of human capital and the matching coordination of human capital as well as physical capital should be mentioned. The other solutions, such as trying to correctly guide the flow of talents, optimize the allocation of Human Resources and reducing the mismatch of human capital.

The current demographic transition in China is irreversible. Increasing the labour force participation rate will not prevent the total economically active population from continuing to decline. Under such circumstances, increasing the stock of human capital, improving the efficiency of human capital allocation, and unleashing the potential of human capital will become the core way to maintain China's sustained economic growth.[I.[1]] Human capital has both a human and a capital component, and is expressed as a combination of knowledge, skills, literacy and health, and can be measured by factors such as the quantity and quality of the workforce.[I.[2]] The stock of human capital is equal to the weighted aggregated number of people in the workforce at each level of education multiplied by the amount of investment required to obtain that education.[I.[3]]

The measures of human capital mismatch at this stage can be divided into two categories: the first category focuses on the state of labor allocation, including the measurement of labor factor allocation distortions and the impact of labor mismatch on variables such as total factor productivity.[I.[4]] Based on this, a measure of human capital employment mismatch is further constructed from the perspective of workers' careers by combining the Mincer wage equation.[I.[7]] Or measure the average human capital mismatch by industry based on a hierarchical Bayesian model in the framework of full life-cycle education returns and human capital mismatch measurement.[I.[8]] The second category combines the effective labor model of the Cobb-Douglas production function as the theoretical basis measuring the match between human capital and physical capital and the impact on economic growth.[I.[9]]

There is a polarization of human capital differences between regions.[I.[10]] How to combine the process of specialized human capital formation with the process of industrial restructuring in order to achieve a smooth transition and high-quality economic development in the new era has become an important theoretical and practical issue.[I.[11]] The use of market-based allocation of human capital may create mismatch problems in the process of economic transformation and trigger a lack of incentive to innovate.[I.[12]] The mismatch of human capital makes large-scale R&D investment does not achieve technological progress, resulting in the evolution of dynamic comparative advantage of industries is delayed and the lack of stable economic growth momentum coexists.[I.[13]] And given the total human capital of the society, as a large number of talented people are allocated to the government sector.[I.[14]] There is an optimal human capital allocation ratio in the public sector, and when the actual human capital allocation ratio is greater than the optimal value, a mismatch will arise as an obstacle to achieving steady economic growth[I.[15]]. Problems with the labor market allocation structure have caused relatively large economic losses[I.[16]], China's current

marginal output of human capital has an "inverted threshold effect", and administrative monopoly explains 59.65% of the gap in human capital mismatch between industries[I,[17]17].

Most of the existing literature directly investigates whether the human capital allocation structure has an impact on the economy and verifies whether it has a positive or negative impact. In this essay, based on the analysis of the impact of the matching coordination degree of human capital and physical capital on the economy, we further use the foreign trade volume as the mediating variable to verify whether there is a mediating effect according to the special geographical location of the border area of Heilongjiang Province, analyze the transmission path of the coupling matching coordination degree of human capital and physical capital in the border area of Heilongjiang Province to influence the economic growth, and dig deeper into the economic impact of the human capital allocation situation in the border area. In order to analyze the problem of human capital mismatch in special regions, establish a trade type population growth pole with Russia according to the actual situation of the region, promote trade with talents, promote economy with trade, bring employment with economy, and realize the interactive development of human capital-material capital matching coordination and industrial agglomeration.

II. COUPLING COORDINATION DEGREE MEASUREMENT

The matching and coordination of human capital and physical capital refers to the dynamic linkage between the two types of capital in their respective subsystems that are interdependent or mutually constrained. Since human capital and physical capital in the border area of Heilongjiang Province are each composed of a multidimensional system, the degree of coupling within each can be measured to further analyze the degree of matching between the two types of capital. The human capital stock and physical capital stock are calculated, and the gray correlation method is used to further measure the degree of coordination between the human capital stock and physical capital stock in the border area of Heilongjiang Province.

2.1 Calculation of Human Capital Stock and Physical Capital Stock

Measurement of physical capital stock using the perpetual inventory method K_{it}. Referring to the data of 'National Economic and Social Development Statistical Bulletin' in the border area of Heilongjiang Province. Let H_{it} represent the stock of human capital in each region in each year, and extend the formula for calculating the stock of human capital proposed by Lisheng Shen (1999), the formula for calculating the stock of human capital is:

$$H_{it} = \left. \begin{bmatrix} L_{it1} \cdot \left(REUT \cdot 4 + REHT \cdot 3 + REJT \cdot 3 + REPT \cdot 6 \right) + \\ L_{it2} \cdot \left(REHT \cdot 3 + REJT \cdot 3 + REPT \cdot 6 \right) + \\ L_{it3} \cdot \left(REJT \cdot 3 + REPT \cdot 6 \right) + L_{it4} \cdot \left(REPT \cdot 6 \right) \end{bmatrix} \middle/ PCR \right. \tag{1}$$

Firstly, the total human capital stock in Heilongjiang province is calculated, where $L_{it1}, L_{it2}, L_{it3}, L_{it4}$

represent the number of people with college and above education, high school education, junior high school education and elementary school education, and PCR denotes the consumer price index, referring to the data of China Statistical Yearbook. REUT, REHT, REJT, REPT denote the average education business expenses per student at each academic level in year t, referring to the data in the National Education Expenditure Implementation Statistics Bulletin of the Ministry of Education. The stock of human capital in the border areas of Heilongjiang Province is measured by multiplying the weight of the total population of each area to the total population of Heilongjiang Province by the total stock of human capital.

2.2 Coupling Measurement Index System Construction

According to the calculation method of human capital stock it is known that the sub-series group of human capital stock can be divided according to the years of education, and the physical capital stock is divided according to the structure of the three major industries in the current period.[I,][18] The proportion of each industry in the current period is used to apportion the total physical capital stock of the region in that year, and the system of measurement indicators is shown in Table I.

TABLE. I. Coupling Degree Measurement Index System

Primary Indicators	Secondary Indicators
Stock of Human Capital in Border Areas of Heilongjiang Province $H_i(t)$	Human Capital Stock of Employees With Last Education of Elementary School H_1
	Human Capital Stock of Employees With Last Education of Junior High School H_2
	Human Capital Stock of Employees With Last Education of High School H_3
	Human Capital Stock of Employees With Last Education of College and Above H_4
Stock of Physical Capital in Border Areas of Heilongjiang Province $K_j(t)$	Physical Capital Stock of Primary Industry K_1
	Physical Capital Stock of Secondary Industry K_2
	Physical Capital Stock of Tertiary Industry K_3

2.3 Human Capital and Physical Capital Coupling Degree Measurement

The GRA method is applied to establish the spatial coupling model, and the data are dimensionless by using the method of polarization to find the correlation coefficient $R_{ij}(t)$. $H_i'(t)$ and $K_j'(t)$ are the normalized values of human capital stock and physical capital stock respectively. θ reflecting the significance of the difference between the correlation coefficients, which takes the value of 0.5 in general, we have

$$H_i'(t) = \frac{H_i(t) - \min_i H_i(t)}{\max_i H_i(t) - \min_i H_i(t)} \tag{2}$$

$$K'_j(t) = \frac{K_j(t) - \min\limits_{j} K_j(t)}{\max\limits_{j} K_j(t) - \min\limits_{j} K_j(t)} \tag{3}$$

$$R_{ij}(t) = \frac{\min\limits_{i} \min\limits_{j} \left| H'_i(t) - K'_j(t) \right| + \theta \max\limits_{i} \max\limits_{j} \left| H'_i(t) - K'_j(t) \right|}{\left| H'_i(t) - K'_j(t) \right| + \theta \max\limits_{i} \max\limits_{j} \left| H'_i(t) - K'_j(t) \right|} \tag{4}$$

Summing up the correlation coefficients into subseries groups of human capital stock. Let n and m be the sample data. Find the Correlation $r_{ij}(t)$ and Coupling degree $\rho_i(t)$ from this:

$$r_{ij}(t) = \frac{1}{n} \sum_{i,\ j=1}^{n} R_{ij}(t) , \text{(n=1, 2, 3……)} \tag{5}$$

$$\rho_i(t) = \frac{1}{m} \sum_{i=1}^{m} r_{ij}(t) , \text{(m=1, 2, 3, 4)} \tag{6}$$

The coupling coordination takes a value between 0 and 1. If the coupling coordination degree takes the value of 0 to 0.35 is low correlation, it indicates that the role of human capital and physical capital sequence group is very weak and uncoordinated match. If the value of coupling coordination is 0.35 to 0.7, it indicates that human capital is weakly related to physical capital and the matching coordination is average. If the value of coupling coordination is 0.7 to 0.85, it indicates that the two have a high degree of correlation, and the interaction between human capital and physical capital sequence group is strong and the degree of matching is high. When the coupling coordination degree takes the value of 0.85 to 1, it indicates that the two have a very high degree of correlation and the relative changes of human capital and physical capital sequence groups are almost identical. Therefore, the sample data were substituted into the coupling coordination measurement model, and the results are shown in Table II.

TABLE. II. Coupling Coordination in Border Areas of Heilongjiang Province

ρ_{ij}	Daxinganling	Heihe	Yichun	Hegang	Jiamusi	Jixi	Mudanjiang
2006	0.57	0.57	0.57	0.58	0.62	0.65	0.59
2007	0.57	0.57	0.58	0.59	0.58	0.65	0.59
2008	0.58	0.57	0.58	0.61	0.57	0.61	0.58
2009	0.58	0.58	0.66	0.66	0.58	0.58	0.58
2010	0.59	0.59	0.69	0.68	0.67	0.62	0.59
2011	0.58	0.58	0.65	0.69	0.65	0.65	0.59
2012	0.57	0.60	0.58	0.64	0.65	0.66	0.58
2013	0.57	0.59	0.62	0.63	0.64	0.63	0.57
2014	0.58	0.59	0.59	0.59	0.65	0.58	0.58
2015	0.58	0.59	0.58	0.59	0.61	0.58	0.59
2016	0.58	0.58	0.58	0.58	0.62	0.58	0.59

2017	0.58	0.58	0.58	0.63	0.63	0.59	0.60
2018	0.58	0.57	0.57	0.63	0.58	0.58	0.59
2019	0.58	0.57	0.58	0.61	0.57	0.57	0.61

As can be seen from Table 2, the coupling coordination degree of human capital and physical capital in the border area of Heilongjiang Province is between 0.35 and 0.7, which indicates that the correlation between human capital and physical capital in the cities and counties in the border area of Heilongjiang Province is weak and the matching coordination is average. In order to further judge the mismatch between human capital and physical capital in the border area of Heilongjiang Province, the coupling coordination degree of the two is used as the sample data to construct a regression model on the economic growth In order to further determine the mismatch between human capital and physical capital in the border areas of Heilongjiang Province, the coupling coordination of the two is taken as the sample data, and the regression model of the impact on economic growth is constructed for empirical test analysis.

III. AN EMPIRICAL ANALYSIS OF THE IMPACT ON ECONOMIC GROWTH

By measuring the stock of human capital in the border area of Heilongjiang Province, the allocation level of human capital in the region can be roughly grasped, and the structural level of human capital allocation is reflected by the matching and coordination degree with physical capital, while whether there is a mismatch of capital in the region is subject to further analysis based on its impact on economic growth. Accordingly, it is assumed that the regional economic growth depends on the stock of human capital and physical capital, and the regional economic growth efficiency depends on the degree of matching and coordination between human capital and physical capital. Based on the measurement results of the coupling and coordination degree of human capital and physical capital in the border area of Heilongjiang Province, we analyze how it affects the economic growth rate, so as to further analyze the human capital mismatch problem in the border area of Heilongjiang Province.

3.1 Econometric Modeling

The Solow model is deformed by adding the accumulation of human capital and physical capital, thus becoming an extended model for the transition from the Solow model to the MRW model. Panel fixed effects are used to verify the impact of the coordination degree of matching human capital and physical capital on the economy, and the following econometric equations are established.

$$Lngrowth_{it} = \gamma_1 \rho_{it} + \gamma_2 LnX_{it} + \gamma_0 + \varepsilon_{it} \qquad (7)$$

X_{it} is a series of control variables, ε_{it} is the error term, γ_0, γ_1 and γ_2 are the parameters to be estimated, and the data from 2006 to 2019 are selected with reference to the Statistical Bulletin of National Economic and Social Development. Variable names and statistical descriptions are shown in Table III.

TABLE. III. Statistical Description of Variables

Variable Code	Variable Name	MEAN	SD	MIN	MAX	MEDIAN
$Lngrowth_{it}$	Economic Growth Rate (GDP in logarithm)	5.77	0.69	3.92	7.03	5.76
ρ_{ij}	Coupling Coordination	0.60	0.03	0.57	0.69	0.59
$LnFT_{it}$	Foreign Trade (total import and export data taken as logarithm)	1.90	1.94	-2.36	5.93	2.04
$LnET_{it}$	Foreign Trade Exports (exports take logarithm)	2.83	1.97	-1.22	6.13	2.65
$LnIT_{it}$	Foreign Trade Imports (imports take logarithm)	1.92	2.45	-4.38	6.19	2.24
$LnTrade_{it}$	Domestic Trade (total social consumption goods taken as logarithm)	4.77	0.88	2.94	6.60	4.75
$LnTourism_{it}$	Tourism (total tourism revenue amount taken as logarithm)	3.35	1.14	-0.51	5.33	3.51
$LnPassenger_{it}$	Transportation (road passenger volume taken as logarithm)	6.80	1.16	4.37	8.42	6.72
$LnTax_{it}$	Total Tax Revenue (total tax revenue at the end of the period is taken as logarithm)	2.61	1.45	-6.38	4.75	2.78
$LnFinancial_{it}$	Finance (financial institution deposit balances taken as logarithm)	6.24	0.66	4.71	7.40	6.30
$LnAgriculture_{it}$	Agriculture, Forestry, Animal Husbandry and Fishery (the value added of the primary industry is taken as a logarithm)	4.66	0.66	2.95	5.88	4.64

3.2 Results of The Measurement

Based on regional panel data from 2006 to 2019, fixed effects regression analysis was performed on the econometric regression model using stata15.1 software, and the econometric results are shown in Table IV(1).

TABLE. IV. Results of Fixed Effects Regression Analysis

Variable Code	(1)	(2)
	$Lngrowth_{it}$	$Lngrowth_{it}$
ρ_{ij}	1.185816**	1.161776**
	(0.4888982)	(0.5100086)
	-0.3191292	-0.2929068

$LnTrade_{it}$	(0.2228791)	(0.2223538)
$LnTourism_{it}$	0.0235162	-0.0099437
	(0.0328824)	(0.0381407)
$LnPassenger_{it}$	0.0715482	0.0788373
	(0.0481359)	(0.0563923)
$LnTax_{it}$	-0.0288587**	-0.0253714*
	(0.0136907)	(0.0137566)
$LnFinancial_{it}$	0.333188	0.3110307
	(0.2489638)	(0.2658899)
$LnAgriculture_{it}$	0.6886728***	0.7007139***
	(0.1077193)	(0.1045417)
$LnFT_{it}$		0.04509**
		(0.0179325)
$LnET_{it}$		-0.0165229
		(0.0296088)
$LnIT_{it}$		-0.0061986
		(0.0130138)
_cons	0.813077	0.8078469
obs	91	91
R-squared	0.8859	0.8979
rho	0.92334876	0.91432983

Note. *, **, *** indicates significant at the 10%, 5% and 1% levels respectively and values in brackets are standard errors.

From the results of the regression (1) analysis in Table IV, it is clear that rho= 0.92334876 indicates that the variance of the composite disturbance term is mainly from individual effects rather than time effects. The coefficient of ρ_{it} is 1.19 and significant at the 5% level, indicating that the coordination of human capital and physical capital matching in border areas of Heilongjiang Province has a significant positive effect on economic growth rate. ρ_{it} increases by 0.1 and economic growth increases by 0.119, indicating that the higher the degree of coordination between human capital and physical capital matching in Heilongjiang Province, the more it can promote economic growth. Therefore, in order to promote the economic development of the border areas in Heilongjiang Province, we should focus on improving the coordination of matching human capital and physical capital.

IV. ANALYSIS OF THE TRANSMISSION PATH OF THE INTERMEDIARY EFFECT

4.1 Intermediation Effect Model Test

Based on the special geographical location of the border area of Heilongjiang Province and the closer

trade with Russia, foreign trade is considered as a mediating variable to explore whether there is a mediating effect. Referring to Wen Zhonglin (2014)[I.][19] stepwise method to verify the mediating effect. Construct a mediating effects model and use the following regression equation to describe the relationship between the variables.

$$Lngrowth_{it} = \lambda\rho_{it} + \mu_1 LnFT_{it} + \mu_2 LnIT_{it} + \mu_3 LnTrade_{it} + \mu_4 LnTourism_{it}$$
$$+ \mu_5 LnPassenger_{it} + \mu_6 LnTax_{it} + \mu_7 LnFinancial_{it} + \mu_8 LnAgriculture_{it} + e_1 \tag{8}$$

$$LnET_{it} = \alpha\rho_{it} + \mu_1' LnFT_{it} + \mu_2' LnIT_{it} + e_2 \tag{9}$$

$$Lngrowth_{it} = \lambda'\rho_{it} + \beta LnET_{it} + \mu_1'' LnFT_{it} + \mu_2'' LnIT_{it} + \mu_3'' LnTrade_{it} + \mu_4'' LnTourism_{it}$$
$$+ \mu_5'' LnPassenger_{it} + \mu_6'' LnTax_{it} + \mu_7'' LnFinancial_{it} + \mu_8'' LnAgriculture_{it} + e_3 \tag{10}$$

Where the coefficient λ of equation (1) is the total effect of ρ_{it} on $Lngrowth_{it}$. The coefficient α of equation (2) is the effect of ρ_{it} on the mediating variable $LnET_{it}$. The coefficient β of equation (3) is the effect of the mediating variable $LnET_{it}$ on $Lngrowth_{it}$ after controlling for the effect of ρ_{it}. The coefficient λ' is the direct effect of ρ_{it} on $Lngrowth_{it}$ after controlling for the effect of $LnET_{it}$. e_1, e_2 and e_3 is the regression residual. The intermediate effect is equal to the indirect effect, which is the product of the coefficients $\alpha\beta$. It is related to the total and direct effects as follows: $\lambda = \lambda' + \alpha\beta$.

TABLE. V. Results of the Intermediary Effect Test

Variable Code	(1)	(2)	(3)
	$Lngrowth_{it}$	$LnFT_{it}$	$Lngrowth_{it}$
ρ_{ij}	1.21537**	7.982855*	1.267397**
	(0.5860015)	(4.196437)	(0.5714972)
$LnTrade_{it}$	0.0986396		0.0825164
	(0.0929857)		(0.0908836)
$LnTourism_{it}$	-0.0504295		-0.0538848*
	(0.0316596)		(0.0308883)
$LnPassenger_{it}$	0.1122426***		0.0673952**
	(0.0260557)		(0.0673952)
$LnTax_{it}$	0.0214742		0.0137301
	(0.0160735)		(0.0160207)
$LnFinancial_{it}$	0.4088597**		0.5373845***
	(0.1893742)		(0.1928065)
$LnAgriculture_{it}$	0.2273248**		0.1567477**
	(0.0707323)		(0.0754412)
	0.0735902***	0.7396118***	0.0486834**

$LnFT_{it}$	(0.0193839)	(0.1335115)	(0.0217696)
$LnIT_{it}$	-0.0015383	0.0366555	-0.0011671
	(0.0136473)	(0.1053955)	(0.0133001)
$LnET_{it}$			$0.0431376**$
			(0.0187429)
_cons	0.1756854	-3.428612	0.0097398

Note. *,**,***indicates significant at the 10%, 5% and 1% levels respectively and values in brackets are standard errors.

The proportion of the tested partial mediating effect to the total effect is $\alpha\beta/\lambda = 28.33\%$. Foreign trade in border areas of Heilongjiang Province can be one of the transmission paths through which the coordination of human capital and physical capital matching affects economic growth, and the coordination of human capital and physical capital matching in border areas of Heilongjiang Province affects economic growth rate through foreign trade.

According to the measurement results in Table 5(2), it is clear that there is a significant positive effect between the coordination of human capital and physical capital matching and foreign trade exports and the coefficient is 7.98. Due to the more frequent trade with Russia in the border areas of Heilongjiang Province, a large amount of human capital input is required, and the match between human capital and physical capital increases by 0.1 and the foreign trade volume increases by 0.798.

Attracting talent pools to develop trade with Russia and enhancing economic cooperation with Russia in various forms by upgrading physical capital. Such as the development of financial integration to promote trade exchanges with Russia. Construction of a venue to hold an exhibition and sale of Russian specialties. The "Heilongjiang Border Highway No. 1" is designed to develop transportation to increase trade with Russia. Accordingly, the radiation effect of foreign trade is used to increase the economic growth rate and make the balanced economic and social development in the border areas of Heilongjiang Province.

V. CONCLUSION

This essay focuses on the matching coordination of human capital and physical capital to influence economic growth through the transmission path of foreign trade in the border areas of Heilongjiang Province. Based on the panel data of border areas in Heilongjiang Province from 2006 to 2019, a fixed-effects regression model is applied to verify that the improvement in the coordination of human capital and physical capital matching helps promote economic growth. The transmission path of the impact on economic growth is further examined through the mediating effect model, whereby the method enhances the match between human capital and physical capital designs the population development poles corresponding with other cities. The conclusions drawn in this paper are as follows:

First, the coordination of human capital and physical capital matching is low in the border areas of

Heilongjiang Province, with the most of them between 0.35 and 0.7.

Second, matching coordinating human capital and physical capital can significantly contribute to local economic growth in the border areas of Heilongjiang Province.

Third, there is a partial intermediary effect to make the matching of human capital and physical capital coordinated to affect economic growth through foreign trade in this area. Furthermore, the proportion of intermediary effect occupied 28.33%.

Fourth, the matching of human capital and physical capital can be improved by designing population development poles in this area. With the assistance of the agglomeration function and development pole of the trade type population with Russia, this area can Develop new forest economy, optimize the adsorption function of ecotourism-based population development pole., release the underwriting function of the development pole about the anti-poverty type population as well as promote a better match between human capital and physical capital.

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